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# **Production Chains, Exchange Rate Shocks, and Firm Performance**

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## Production Chains, Exchange Rate Shocks, and Firm Performance\*

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**Abstract:** Using unique Japanese firm-level production network data combined with international trade data, we examine the upstream/downstream propagation effects of exchange rate shocks on the performance of indirect exporters/importers. Indirect exporters (importers) are defined as firms which do not export (import) by themselves but supply to (buy from) at least one exporting (importing) firm. We construct firm-specific export and import effective exchange rates to take account of the variations of exchange rate exposure across trading firms. We find significant and robust responses in sales and profitability of indirect exporters to exchange rate shocks of downstream exporting firms, which suggests the upstream propagation effect of exchange rate shocks. Both the sales and profitability of the indirect exporters improved significantly with yen depreciation in downstream industries. However, on the other hand, there is weak evidence on the responses of indirect importers to exchange rate exposure of upstream importing firms. Furthermore, the responses in sales and profitability are heterogeneous among direct and indirect exporters/importers by relative firm size and upstreamness in the production chains. Our results suggest that the stabilization of exchange rates is crucial to firm performance, especially to the small and medium enterprises engaging in indirect exporting, from the perspective of supply chains.

*Keywords:* Production network, Exchange rate, Indirect exporter/importer

*JEL classification:* F14, F31, L14

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## 1 Introduction

Large exchange rate shocks can affect firm performance and cause macroeconomic fluctuations. The exchange rate shocks not only affect the sales and profitability of exporters but also that of their domestic suppliers through transaction relationship and propagate to the whole economy. Recently, due to the increasing availability of firm- and transaction-level trade data, a burgeoning literature examines how exporters and importers, price and quantity, respond to exchange rate shocks (Amiti, Itskhoki and Konings, 2014; Berman, Martin and Mayer, 2012; Chatterjee, Dix-Cameiro and Vichyanond, 2013, etc.).<sup>1</sup> Despite the extensive research on exchange rate pass-through as well as exchange rate and international trade, we still know little about how exchange rate affects firm performance through domestic production chains and how exporters and their suppliers interacted with each other when facing with exchange rate fluctuations. Importantly, there is a lack of high-quality data that can observe the inter-firm transaction relationship as well as characteristics of a firm's upstream and downstream firms. In this paper, we utilize a novel and comprehensive firm-level production network data from Japan and try to fill this gap.

We use Japanese micro-data covering exporters and their suppliers (indirect exporters), and importers and their buyers (indirect importers) to study the direct effects and the propagation effects of exchange rate shocks on firm performance. Indirect exporters (importers) are defined as firms who do not export (import) by themselves but supply to (buy from) at least one exporting (importing) firm. As the stylized facts of indirect export are similar to indirect import, we look at the export side here. Indirect exporters make a large portion of domestic production and exports. Specifically, in manufacturing industries, only 6% of Japanese firms export directly but about 52% of firms are indirect exporters in terms of manufacturer-manufacturer pair. Indirect exporters account for 36% of total sales and 46% of employment and in contrast, direct exporters account for 57% and 41%, respectively (authors' calculation based on TSR database 2013). This pattern is more prominent when we look at some specific firms. Toyota, the largest automobile manufacturer in the world, has about 500 suppliers (1-tier) and more than 9000 sub-suppliers (2-

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<sup>1</sup> See Burstein and Gopinath (2014) for a recent survey on exchange rate pass-through and international trade.

tier) in Japan.<sup>2</sup> Even one of major suppliers of Toyota, Denso, has more than 1500 domestic suppliers. Denso supplies a half of its products in terms of transaction amount to Toyota and another half to Honda, Suzuki, and many other automobile makers.<sup>3</sup> In fact, most of these small domestic firms supply to Toyota and/or Denso do not export directly by themselves. Furthermore, wholesalers and trade intermediaries also play an important role. In 2013, about 19% of manufactures who do not export by themselves but supply their products to at least one exporting wholesaler, and wholesalers account for roughly 24% of exporters and 25% of export value in Japan (Fujii, Ono and Saito, 2017). In China, the largest developing country and exporter in the world, intermediaries account for around 20% of China's total exports in 2005 (Ahn, Khandelwal and Wei, 2011).

Our data contains firm-level buyer-supplier linkage information and balance sheet variables including exports, imports, profits, and sales. Therefore, it allows us to estimate the effects of exchange rate changes on the sales and profitability of direct and indirect exporters/importers, and examine how exchange rate shocks transmit along the domestic supply chains. In the empirical analysis, we address the variations of exchange rate exposure across firms by constructing firm-specific export and import effective exchange rates (EER) which are regional exports and imports weighted. We find that a depreciation of Yen significantly increased the exports, sales and profitability of Japanese firms. This is direct effect. More importantly, there are significant responses in sales and profitability of indirect exporters to exchange rate shocks of downstream exporting firms (upstream propagation effect), but the responses are not significant to upstream exchange rate shocks. In other words, both the sales and profitability of Japanese indirect exporters improved significantly when Yen had a depreciation in downstream industries. Furthermore, our results show that the effects of exchange rate shocks are asymmetric among firms by trade mode (direct vs indirect), firm size (large vs small), industry (manufacturing vs

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<sup>2</sup> According to a report on the transaction relationship in automobile industry done by Teikoku Databank in 2013 that submitted to the Ministry of Economy, Trade and Industry (METI): [http://www.meti.go.jp/medi\\_lib/report/2014fy/E003915.pdf](http://www.meti.go.jp/medi_lib/report/2014fy/E003915.pdf) (in Japanese)

<sup>3</sup> Here is an brief introduction about Denso's business (in Japanese): [https://next.rikunabi.com/tech/contents/ts\\_free/img/denso/deta02.html](https://next.rikunabi.com/tech/contents/ts_free/img/denso/deta02.html)

wholesalers) and upstreamness (first degree vs second degree).

The Japanese economy is ideal to study the upstream/downstream propagation effects of exchange rate shocks on firm performance as it experienced a series of drastic exchange rate and trade fluctuations. Figure 1 illustrates the time path of the annual exports, imports and the nominal exchange rate of between the Japanese Yen and US Dollar. An increase in Yen/USD exchange rate implies a depreciation of Yen. The Japanese Yen faced a sharp appreciation and depreciation in 1990s and it faced another period of sharp appreciation in 2009 due to global financial crisis. However, after the Abenomics in 2012, the Japanese Yen depreciated sharply by more than 25% between 2012 and 2013. In addition to the Yen/USD exchange rate fluctuations, there have been substantial variations both across destinations and over time in the real Yen exchange rates relative to other regions. This is clear when we compare the Yen exchange rate against Asia with it against Europe or with it against Northern America and Middle East. Figure 2 shows substantial variations of changes of Yen against its trading regions.<sup>4</sup>

[Insert Figure 1 here]

[Insert Figure 2 here]

**Related Literature**—Our paper contributes to several strands of literature. First, it is related to recent literature on exchange rate pass-through and firm performance and activities with firm heterogeneity. Most existing studies on exchange rate pass-through use aggregated trade data, for example, Shimizu and Sato (2015), Thorbecke and Kato (2012) study the case of Japan. Recent studies have linked the exchange rate pass-through or elasticity to firm-level characteristics. Berman, Martin and Mayer (2012) study export price responses to exchange rate movements from French firms and find that compared with low productivity firms, high productivity firms react to a depreciation by increasing more their markups and less their export quantity. Li, Ma and Xu

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<sup>4</sup> In our firm-level data, firms report their exports and imports by major region: Asia, Middle East, Europe, Northern America, and the rest of the world (ROW). We show regional variations of exchange rate here and we use firm-specific regional trade weighted exchange rate in the empirical analysis.

(2015) conduct a similar analysis for the case of Chinese firms. Using Brazilian customs data, Chatterjee, Dix-Cameiro and Vichyanond (2013) illustrate how heterogeneous firms adjust product scope in the event of exchange rate depreciation and how the degree of price and quantity responses varies across products within firms. Amiti, Itskhoki and Konings (2014) emphasized the intensity of imported inputs may affect the price responses of exporters to exchange rate movements. Furthermore, using transaction-level trade from China's Customs, Dai and Xu (2017) construct export-weighted and import-weighted exchange rates at the firm level and examine how exchange rate shocks affect employment and labor reallocation across firms. To our knowledge, this is the first paper to examine the upstream/downstream propagation effects of firm-level exchange rate shocks on the performance of indirect exporters/importers and study how exchange rate shocks transmit through buyer-supplier linkage and domestic value chains. In this sense, our paper does not focus on the traditional exchange rate pass-through, i.e., the response of export price and quantity. We examine the responses of sales and profitability at direct and indirect exporter/importer levels. This is our main contribution of this study.

This paper is also connected to the literature investigates the propagation of shocks via production chains. Carvalho, Nirei and Saito (2014), Barrot and Sauvagnat (2016), Boehm, Flaaen and Pandalai-Nayar (2016) exploit the natural disasters to examine the propagation and amplification of exogenous shocks through firm-level linkages. Using production network data from Belgium and Japan, Tintelnot, Kikkawa, Mogstad and Dhyne (2017) and Fujii (2017) confirms that there is a significant propagation effect –the import shocks to a firm's suppliers and the export shocks to a firm's buyers do affect the total sales of the firm. However, they do not identify the exchange rate shocks from other potential source of shocks, either demand or supply shocks or others if any. This study compliments and contributes to the previous studies in three ways. First, we construct firm-specific exports- and imports- weighted effective exchange rates to capture the direct exchange rate exposure across firms. We examine the impact of exchange rate changes on firm performance through the import cost channel and export price channel controlling for supply and demand shocks. Second, we investigate both the direct and indirect (propagation) effects of exchange rate shocks. Specifically, from the perspective of value chains, a firm's sales and

profitability should be affected by three channels of exchange rate shocks: (i) the direct effect of firm-specific export/import exchange rate shocks if the firm export or import, (ii) the *downstream propagation effect* of import exchange rate shocks of upstream suppliers (importers), and (iii) the *upstream propagation effect* of export exchange rate shocks of downstream customers (exporters). Note that a firm may import and/or export directly and meanwhile it outsources inputs from other importers and/or supplies its products to other exporters (see Figure 3). Third, we show the propagation effects of exchange rate shocks are asymmetric among firms by various dimension such as trade mode (direct vs indirect), firm size (large vs small), industry affiliation (manufacturing vs wholesalers) and firm upstreamness (first degree vs second degree).

[Insert Figure 3 here]

Our study also relates to growing literature on the global value chains (GVC) and exchange rates. Bems and Johnson (2012, 2017) and Bayoumi, Saito and Turunen (2013) allow for trade in intermediates and compute the real effective exchange rates weighting matrix at the country level. Patel, Wang and Wei (2014) propose a comprehensive measure of sector level value added price index and build sector level exchange rates. Using a panel data of 46 countries over the period 1996-2012, Ahamed, Appendino and Ruta (2015) show that due to the rising participation in GVC, the elasticity of manufacturing export volume to the real effective exchange rate has decreased over time. Compared with these works, our study utilizes a comprehensive firm-level production network data from Japan and focuses on domestic value chains. Japan is one of the major exporters in the world and Japanese firms are famous for their well-organized supply chains.

The rest of the paper is organized as follows. Section 2 describes the data and variables. In Section 3, we present the empirical analysis results and do further discussions in Section 4. Section 5 concludes.

## **2 Data and variables**

We use two datasets to implement our analysis. The first one is the production network data with

buyer-supplier linkage information and the second is annual firm-level data containing exports and imports variables. We match these two data to identify direct and indirect exporters/importers. Using firm-level trade data combined with economy-wide aggregate data, we construct firm-specific export/import effective exchange rates.

## **2.1 Production network and firm trade data**

**Production network data**—We utilize the production network data for the years 2005, 2010, 2011, and 2013 assembled by Tokyo Shoko Research (TSR). The data for 2005 contains information on more than 950,000 firms, which represent more than half of all the firms in Japan and covers all sectors of the economy. The data provides information on basic firm characteristics and buyer-supplier relationships. Firm characteristics data contains sales and profits for the past two years, number of employees, industry affiliation, etc. Importantly, the buyer-supplier relationship data reports the firm's buyers, suppliers, and major shareholders. Each firm reports a list of their most important suppliers and buyers (both are up to 24). Following Bernard, Moxnes and Saito (2018), we combine both self-reported and other-reported information for each firm in the data to maximize the number of buyer-supplier links.

As these cross-sectional data is not a census or survey collected by the government, firm information does not update on an annual basis. To identify the effect of exchange rates shocks to importers/exporters on the performance of indirect importers/exporters through value chains, we restrict our sample to firms for which buyer-supplier linkage (pair) did not change between any two cross-sections, that is, from 2005 to 2010, from 2010 to 2011, from 2011 to 2013. We assume the transaction relationship between any two firms does not change if their linkages exist in at least two consecutive cross-section. Therefore, we exclude buyer-supplier pairs that only exist for one cross-section from our analysis. Furthermore, following Carvalho, Nirei and Saito (2014), Fujii, Ono and Saito (2017), we drop firms (i) whose fiscal term is not 12 months, (ii) sales is zero, missing or negative, (iii) the number of suppliers or the number of customers is zero.

**Firm-level trade data**—This data come from the Basic Survey of Japanese Business Structure



and Activities (*Kigyo Katsudo Kihon Chosa* in Japanese, Kikatsu henceforth) conducted by the Ministry of Economy, Trade and Industry (METI) of Japan for the period 2005 to 2013. This annual national survey is mandatory and it provides information about business activities of Japanese firms and covers firms from a large set of industries that employ more than 50 workers and have more than 30 million Japanese yen in total assets.<sup>5</sup> This dataset contains information about firm activities such as sales, employment, intermediate inputs and industry affiliation. As for international trade activities, the dataset reports firm exports and imports by major region, i.e., Asia, Middle East, Europe, Northern America, or rest of the world (ROW).<sup>6</sup> Importantly, we use these exports/imports information to construct regional exports/imports weighted firm-level exchange rates. The number of observation is more than 20,000 firms each year and a half is in manufacturing. We exclude firms whose sales, profits, exports, imports, employment information are zero, missing or negative.

**TSR-Kikatsu matched data**—We obtain buyer-supplier connections from the TSR data and firm exports and imports variables from the Kikatsu data. We then merge these two data sets using firm’ name, address and telephone number. About 80% of Kikatsu firms are matched to TSR firms in each year (2005, 2010, 2011 and 2013).<sup>7</sup> Our matched direct exporter and indirect exporter data contains over 2,500,000 buyer-supplier pairs. The number of direct exporters is about 3,000 in each year. For each direct exporter, the average number of indirect exporters is 63 and the median is 22. This study mainly focuses on manufacturing firms and wholesalers.<sup>8</sup> Furthermore, we use industry-level input and output deflator from the Cabinet Office to realize the main variables in the regressions.

## 2.2 Descriptive statistics of indirect exporters/importers

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<sup>5</sup> The industries included are mining, manufacturing, wholesale and retail trade, and eating and drinking places (excluding “Other eating and drinking places”).

<sup>6</sup> As the Kikatsu data is not customs data, firms do not report exports/imports transaction records by country and product.

<sup>7</sup> See Bernard, Moxnes and Saito (2018) and Furusawa, Inui, Ito and Tang (2018) for the details and matching of these two datasets.

<sup>8</sup> Manufacturers are firms with 2-digit Japan Standard Industrial Classification (JSIC) code between 09 and 32 and the wholesalers are firms with 2-digit JSIC code between 50 and 55.

In this paper, we define direct exporters (importers) are firms who report exporting (importing) activities in the Kikatsu data. Using the TSR-Kikatsu matched data, indirect exporters are defined as firms who do not export by themselves but supply their product to at least one exporting firm. Similarly, indirect importers are defined as firms who do not import by themselves but have sourcing from at least one importing firm. We call them 1-tier indirect exporters/importers. To dig deeper the importance of indirect trade, we further identify 2-tier exporters as firms that are not direct exporters or 1-tier exporters but one of their buyers' buyers exports. We define 2-tier importers similarly.

Table 1 reports the summary statistics of indirect exporters and indirect importers. The TSR data in 2013 contains firms' trade status that is categorized to exporting, importing, both exporting and importing, and domestic (non-exporting and non-importing) firms. Since this trade status variable is only available in 2013, we rely on our matched TSR-Kikatsu data 1 and 2 for panel data analysis. We show that the results using matched data are consistent with trade patterns observed in the TSR data in 2013.

[Insert Table 1 here]

We have two matched data, TSR-Kikatsu 1 and TSR-Kikatsu 2. The TSR-Kikatsu 1 covers direct exporters/importers, 1-tier and 2-tier exporters/importers, and other firms. The TSR-Kikatsu 1 shows that only 2% of firms export directly. Meanwhile, more than about 68% of firms are 1-tier indirect exporters and 28% of firms are 2-tier indirect exporters. We can see that up to 2-tier, almost all firms are linked together through domestic value chains within manufacturing sectors. This is also the same if we look at the importing side. In our empirical analysis, we use the panel data from 2009 to 2013 to examine how exchange rates shocks transmit from exporters to these 1-tier and 2-tier exporters.

The TSR-Kikatsu 2 are restricted to firms that have both buyer-supplier linkage information in the TSR data and firm-level variables reported in the Kikatsu data. As the Kikatsu data only covers

relatively big firms with 50 or more employees and paid-up capital is over 30 million yen, the second data is much smaller than the TSR data that does not have threshold on employees and capital. Now we only have three types of firms: direct exporters, indirect exporters and other firms. The TSR-Kikatsu 2 shows that about one third of firms export or import directly and more than 50% of firms are indirect exporters/importers. We use this alternative subsample for robust checks of our regression results since the Kikatsu data is an annual survey with rich information on firm activities that allows us to construct a panel data from 2005 to 2013 without gap. We verified that our findings remain unchanged.

Figure 4 shows the share of sales by trade status in the TSR-Kikatsu 1. Direct exporters account for about 35% of total sales. 1-tier and 2-tier indirect exporters have 57% and 6%, respectively. The pattern is very similar at the importing side.

[Insert Figure 4 here]

### 2.3 Construction of firm-specific effective exchange rates

We use annual Kikatsu data to construct firm-specific *export / import* effective exchange rates (*EXEER*):

$$(1) \quad \Delta EXEER_{ft} = \sum_R \frac{EX_{f,t-1}}{EX_{f,t-1}} \times \Delta RER_{rt}, \quad \Delta IMEER_{ft} = \sum_R \frac{IM_{f,t-1}}{IM_{f,t-1}} \times \Delta RER_{rt},$$

$$\text{where } \Delta RER_{rt} = \sum_r \frac{GDP_{ct}}{GDP_{rt}} \times \Delta \ln RER_{J/c,t}; \quad RER_{J/c,t} = \frac{NER_{J/US,t}}{NER_{c/US,t}} \times \frac{CPI_{ct}}{CPI_{Jt}}.$$

$f$  is firm,  $t$  is year and  $c$  is country respectively.  $r$  denotes Asia (excluding Middle East), Middle East, Europe, North America, or rest of the world (ROW). Note that Kikatsu data only reports firm-level exports and imports value by region  $r$ .  $EX_{f,t-1}$  and  $EX_{f,t-1}$  are exports value lagged for one period to avoid potential endogeneity. We obtain data on bilateral exchange rate (local currency/US Dollar), consumer price indices (CPIs) and GDP measured at constant price for

different destinations from the Penn World Trade (PWT) 9 database. An increase in  $EXEER_{ft}$  implies a depreciation of Yen at the firm level. Using the same methodology, we also construct firm-level *import* effective exchange rates,  $IMEER_{ft}$  and its percentage change. The correlation between  $EXEER_{ft}$  and  $IMEER_{ft}$  is 0.62.

Firms in the Kikatsu data exhibit considerable variations in export and import intensity, i.e., the share of exports to total sales and the share of imports to total sourcing. Some firms are highly reliant on foreign markets for sales and sourcing inputs. This suggests that the impact of a given exchange rate shock can vary substantially across firms and to the indirect exporters and importers. To capture the variation of firms' exchange rate exposure on the export and import market, we define *export (import) exchange rate exposure* as the interaction of the firm's export (import) share and its regional export-weighted (import-weighted) effective exchange rate changes, that is,  $EXEER_{ft} \times exshare_{ft-1}$  ( $IMEER_{ft} \times imshare_{ft-1}$ ). The export share is the share of exports to total sales and the import share is the share of imports to total sourcing. The correlation between export exchange rate exposure  $EXEER_{ft} \times exshare_{ft-1}$  and import exchange rate exposure  $IMEER_{ft} \times imshare_{ft-1}$  is 0.27.

There are substantial variations in export and import exchange rates across exporters and importers. Figure 5A plots the distribution of firm-level exchange rate *changes* in 2013 when Yen had a sharp depreciation. Figure 5B plots the distribution of effective exchange rate *exposure* in 2013. Firm-specific effective exchange rates provide substantial cross-firm variations which can be utilized to identify the impact of exchange rate shocks to both exporters (importers) and indirect exporters (importers).

[Insert Figure 5A here]

[Insert Figure 5B here]

### 3 Empirical analysis

In this section, we first empirically examine the effects of exchange rate fluctuations on sales and

profitability of Japanese firms in manufacturing sectors. Then we use matched buyer-supplier production network data to study how the exchange rate shocks affect the firm performance, especially sales and profitability at direct and indirect exporter/importer level.

### 3.1 Specifications

**Direct exporter/importer level**—The basic specification to investigate the effects of exchange rate movements is equation (2) as follows:

$$(2) \quad \Delta Y_{ft} = \mu + \alpha_1 \Delta IMEER_{ft} \times imshare_{ft-1} + \alpha_2 \Delta EXEER_{ft} \times exshare_{ft-1} \\ + \beta_1 \Delta \ln TFP_{ft} + \beta_2 \Delta \ln GDP_{ft} + FE_f + FE_{it} + \varepsilon_{ft}$$

where  $f$  refer to the firm,  $i$  and  $t$  denote industry and year, respectively.  $Y$  represents log sales or profitability, i.e., the share of profits to sales.  $\Delta EXEER_{ft}$  is the change of export real exchange rate and  $\Delta IMEER_{ft}$  is the change of import real exchange rate defined in Section 2.3. A positive figure of  $\Delta EXEER_{ft}$  or  $\Delta IMEER_{ft}$  means a depreciation of Japanese Yen and a negative figure its appreciation during the year. In equation (2),  $exshare$  is defined as the share of exports to sales and  $imshare$  is the share of imports to total intermediates inputs. The exchange rates exposure  $\Delta IMEER_{ft} \times imshare_{ft-1}$  and  $\Delta EXEER_{ft} \times exshare_{ft-1}$  reflect the impact of exchange rate changes on firm performance through the import cost and export price channels, respectively. The coefficients  $\alpha_1$  and  $\alpha_2$  capture the responses of firm sales and profitability to real exchange rate fluctuations and are the key parameters to be estimated.  $\alpha_1$  is expected to be negative and  $\alpha_2$  is expected to be positive if the Japanese Yen had a depreciation.

Regarding control variables, firm TFP estimated by Levinsohn and Petrin (2003) approach is included to control for firm-specific productivity shocks.<sup>9</sup> We also include firm-level regional trade (export and import) weighted real GDP changes defined as

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<sup>9</sup> The results remain robust when we control for log labor productivity (value added per employee).

$$\Delta \ln GDP_{ft} = \sum_R \frac{EX_{fRt-1} + IM_{fRt-1}}{EX_{ft-1} + IM_{ft-1}} \times \Delta \ln GDP_{Rt} \quad \text{to address the potential demand shocks of}$$

foreign markets. We estimate equations (2) using the firm fixed-effects estimator. These within estimators allow us to capture any time-invariant unobservables that are specific to firms. As this is a long panel data, we include industry-year fixed effects to control for the time-variant industry-specific factors, such as input composition and prices. In all specifications, the standard errors clustered at the firm level.

**Direct and indirect exporter/importer level**—Given the domestic production chains, the sales and profitability of a firm depend on not only its direct exchange rate shocks and exposure but also the exchange rate movements in its upstream and downstream firms. Therefore, the estimation results at direct exporter level are likely to be biased due to omitted variables. To take both direct effects and upstream/downstream propagation effects into consideration, we need to examine the effects of exchange rate on sales and profitability at buyer-supplier level using matched TSR-Kikatsu data. Our benchmark buyer-supplier level regression is specified as follows:

$$(3) \quad \begin{aligned} \Delta Y_{ft} = & \mu + \alpha_1 \Delta IMEER_{ft} \times imshare_{ft-1} + \alpha_2 \Delta EXEER_{ft} \times exshare_{ft-1} \\ & + \beta_1 \Delta \ln TFP_{ft} + \beta_2 \Delta \ln GDP_{ft} + FE_f + FE_{it} + \varepsilon_{ft} \\ & + \gamma_1 Upstream_{ft} + \gamma_2 Downstream_{ft} \end{aligned}$$

where  $Upstream_{ft}$  are the average import exchange rate exposure  $IMEER_{st} \times imshare_{st-1}$  of upstream suppliers. Similarly,  $Downstream_{ft}$  is the average export exchange rate exposure  $EXEER_{ct} \times exshare_{ct-1}$  of downstream customers. Since we employ the average of firm characteristics of upstream and downstream firms, the number of observations decrease substantially, compared with the original linkage relationship data. Both  $Upstream_{ft}$  and  $Downstream_{ft}$  are firm specific. Our sample period is from 2005 to 2013 for TSR-Kikatsu data 2, and the period over 2009-2013 for TSR-Kikatsu data 1.

### 3.2 Results

**Direct exporter/importer level**—Table 2 reports the results concerning the responsiveness of firm-level sales and profitability to exchange rates shocks for the period 2005 to 2013 controlling for firm TFP and foreign GDP growth rates. A depreciation of export exchange rate significantly increased the sales and profitability of Japanese firms and firms with higher export intensity tend to enjoy higher sales and profitability growth rates through export price channel. In terms of magnitude, the coefficients of export exchange rate exposure for sales are much larger than that of profitability. On the other hand, at the import side, when there is a depreciation of import exchange rate, Japanese firms are more likely to suffer lower growth in profitability rather than their sales, especially for firms imported intensively through import cost channel. It indicates that the real depreciation of Yen probably does not decrease imports and sales of Japanese firms and the imported intermediates are not likely to be substituted by domestic sourcing. In columns 2 and 4, we also add exchange rate exposure lagged one year to capture some possible long-term effects on firm performance but the effects are quite weak. Regarding control variables, the coefficients of regional trade-weighted GDP growth rate of foreign market and firm TFP growth are positive and statistically significant in log exports and profitability growth regressions, suggesting that in general both the positive demand and supply shocks increase the sales and profitability of Japanese firms.<sup>10</sup>

[Insert Table 2 here]

**Direct and indirect exporter/importer level**—We argue that firm sales and profitability not only respond to its direct export/import exchange rate exposure, but also respond to the exchange rates shocks of its upstream suppliers and downstream customers. We use the TSR

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<sup>10</sup> To validate our measure of firm-level exchange rate changes, we also run a simple regression of export equation as follow.  $\Delta \log EX_{jt} = \mu + \alpha \Delta EXEER_{jt} + FE_f + FE_{it} + \varepsilon_{jt}$ .

The coefficient estimates for the export exchange rate changes  $\alpha$  is about 0.92 at one percent significance level, suggesting that a 10% depreciation of Yen (an increase in exchange rate) leads to an increase of total exports by around 9.2%. Japanese firms tend to increase their exports in response to the depreciation of Yen over foreign currencies. The results are available upon request.

buyer-supplier linkage data combined with the international trade data, TSR-Kikatsu 1, to examine the propagation effects of upstream and downstream exchange rate shocks on indirect exporters and importers.

Recalling the definition of upstream and downstream propagation effects in Figure 3, the results in Table 3 confirm our predictions. First, export exchange rate changes and its interaction terms with lagged firm export share are positively associated with the growth of sales and profitability with statistical significance. On the other hand, firms' direct import exchange rate exposure are negatively associated with profitability growth but not significant. The degree of sales and profitability responses to exchange rate changes depends on its export and import intensity. These results are consistent with those of Table 2, the cases of direct exporters and importers.

More importantly, we find that firm sales and profitability respond *differently* to upstream exchange rate shocks and downstream exchange rate shocks. Firms' sales and profitability responses are not significant to import effective exchange rate exposure (*import cost channel*) of upstream suppliers. The depreciation or appreciation of Yen over foreign currencies in upstream importers are not likely to affect firms' sales and profitability. It suggests that the *downstream propagation effect* is weak. On the contrary, we observe that the export exchange rate exposure of downstream customers are positively associated with firms' sales and profitability growth with high statistical significance. The effects are more substantial if a firm's downstream direct exporters on average have higher export share (*export price channel*). This implies that indirect exporters are likely to increase their sales in response to the depreciation of Yen over foreign currencies in downstream exporters, even after controlling for their TFP and demand shocks. These new and direct evidence show that the propagation effect of exchange rate shocks through domestic production chains, especially from the direct exporters in downstream to indirect exporters in upstream (*upstream propagation effect*) in the case of Japan.

[Insert Table 3 here]



## 4 Discussion and robustness checks

We conduct a series of regressions and checks to ensure that our main results in Table 3 are robust and digger deeper the upstream and downstream propagation effects by focusing on pure indirect traders, examining the heterogeneous effect by firm size, including much smaller firms in the TSR data, and considering second degree propagation effects of exchange rate shocks.

### 4.1 Pure indirect exporters/importers

Firms can have three different modes to serve foreign market: (i) export directly, (ii) export by themselves and supply inputs to other exporters at the same time, and (iii) do not export directly but supply goods to exporters (*pure indirect exporters*). As most firms do not export directly, to examine the upstream propagation effect of exchange rate shocks from downstream exporting firms, we focus on pure indirect exporters in this sub-section. Similarly, it is the same at the import side. For comparison, Table 4 reports the results for pure indirect exporters/importers and continuous exporters/importers. For firms engaging in direct export and import continuously, their sales and profitability not only respond to direct export and import exchange rate exposures, but also the export exchange rate exposure of their downstream customers. As for pure indirect exporters, their sales and profitability increased significantly if their downstream customers experienced a Yen depreciation and the effects were larger when the customers on average had higher export intensity and larger exchange rate exposure. Furthermore, compared with the continuous direct exporters, the upstream propagation effect is much larger to *pure indirect exporters*. Furthermore, the sales and profitability of indirect importers are not likely to be affected by upstream import exchange rate shocks (downstream propagation effect). To pure indirect importers/exporters, the propagation effect come from downstream export price channel rather than upstream import cost channel.

[Insert Table 4 here]

### 4.2 Firm size

It is a well-known fact that exporters and importers are large firms. We expect large firms respond

to its direct exchange rate shocks rather than its upstream or downstream exchange rate exposure. On the other hand, due to large sunk cost for exporting, many SMEs cannot export directly by themselves but supply goods to direct exporters. In this case, we expect their sales and profitability are more responsive to exchange rate exposure of their downstream customers/exporters. To test the possible heterogeneous responses by firm size, we divide our samples into SMEs and large firms and run equation (3) separately. Note that we only focus on own firm size here. According to the Japanese government (Small and Medium Enterprise Agency, Ministry of Economy, Trade and Industry), a firm is defined as SME if its number of employees is less than 300 or its registered capital is less than 30 billion Yen. In our matched data TSR-Kikatsu 2, more than 80% of firms are SMEs during our sample period.<sup>1 1</sup>

Table 5 reports the results. The results in columns 1-2 suggest that, large firms tend to respond to their direct export exchange rate exposure and their sales and profitability improved significantly with Yen depreciation, especially for export intensive firms. Large firms also respond to the export exchange rate shocks of downstream customers in terms of sales but not profitability. However, the magnitude of *direct* export exchange rate exposure (coefficient: 0.965) is much bigger than the *indirect* export exchange rate exposure (coefficient: 0.808). These results make sense since large firms can perform both importing and exporting directly without supplying to their downstream customers and other exporters. Compared with large firms, column 3 shows that SMEs' sales significantly respond to downstream export exchange rate exposure rather than its direct export exchange rate exposure, and their sales growth rates are positively associated with the downstream exporters have higher export intensity when Yen has a depreciation. The coefficient of direct (downstream) export exchange rate exposure is 0.373 (0.991) at one percent significance level. In column 4, the profitability of SMEs is also positively correlated with downstream export exchange rate exposure with statistical significance and similar magnitude of their direct export exchange rate exposure. Same as large firms, the SMEs' responses of sales and profitability to upstream import exchange rate shocks are not significant.

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<sup>1 1</sup> The median of number of employees is 164. The results are quantitatively similar if we define SMEs as firms having less than 164 employees. The results are available upon request.

In sum, the SMEs tend to respond to the depreciation of Yen in downstream industries and increase their sales and profitability by supplying inputs to downstream customers and exporters. The magnitude of upstream propagation effect of exchange rate shocks is large controlling for firm fixed effects and various characteristics of own firms, upstream and downstream firms.<sup>1 2</sup>

[Insert Table 5 here]

### 4.3 Including small firms in TSR data

Our results in Tables 3-5 rely on the matched data TSR-Kikatsu 2 with firms having more than 50 workers and 30 million Japanese yen in total assets. To examine the upstream and downstream propagation effects of exchange rate shocks on much smaller firms, we use the matched data TSR-Kikatsu 1 and which allows us to covers firms with less than 50 employees. Our sample period is from 2009 to 2013 since we do not have sales and profits information before 2009 except 2005. Table 6 reports the results for full sample, Table 7 reports the results on indirect exporters/importers, and Table 8 presents the results by firm size, respectively.

In Table 6, we use full samples in Column 1 and we restrict firms with no missing values of growth rates of profitability in Columns 2-3. The results are consistent with those of Table 3. That is, firms not only respond to firm-specific exchange rate shocks but also upstream and downstream exchange rate shocks. On average, the upstream propagation effect of downstream exchange rate exposure on both sales and profitability are smaller than direct firm exchange rate

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<sup>1 2</sup> We further examine how firm sales and profitability respond to upstream and downstream exchange rate shocks by relative firm size, i.e., its own, upstream and downstream firms. Specifically, we examine the heterogeneous effects among eight possible combinations as follows: own firm is large and upstream importer is large (small), own firm is large and downstream exporter is large (small), own firm is small and upstream importer is large (small), own firm is small and downstream exporter is large (small). Similar with previous results, both large firms and SMEs respond to the export exchange rate exposures of the downstream customers rather than the import exchange rate exposure of the upstream suppliers. The sales and profitability of indirect exporters significantly increase with Yen depreciation in downstream firms. The upstream propagation effect is larger for SMEs than large firms in terms of the magnitude of coefficient of downstream exchange rate exposures. The results are available upon request.

exposure in terms of magnitude. These results make sense since firms respond to direct exchange rate exposure rather than their customers in downstream. As for the import side, firms also respond to upstream import exchange rate exposure and their direct import exchange rate exposure. This is different with the results in Table 3 since here we include much smaller firms in our sample. It suggests that profitability (not sales) of small firms will deteriorate with Yen depreciation through import cost channel, especially when they import directly and their suppliers have higher import intensity and exposure to exchange rate. However, in total, the *upstream propagation effect* of downstream export exchange rate shocks are larger than *downstream propagation effect* of upstream import exchange rate shocks, suggesting that export price channel dominates the import cost channel.

[Insert Table 6 here]

Similar with Table 4, we divide our samples by trade mode (engaging in trade directly or indirectly) and now we have more observations for indirect exporters and importers. Compared with Table 4, Table 7 shows that for indirect importers, the upstream propagation effect on sales turns to be negative and statistically significant, implying that increasing import cost with yen depreciation will decrease the sales of indirect importers. On the other hand, the downstream propagation effect remain robust – lower export prices of downstream exporters increase the sales and profitability of indirect exporters through supply chains. Furthermore, we divided our samples to large firms and SMEs in Table 8 as we did in Table 5. The results remain robust. Compared with large firms, the SMEs tend to respond more significantly to the downstream exchange rate exposure. It implies that when there was a sharp appreciation of Yen in downstream, the sales and profitability of SMEs decreased substantially.

[Insert Table 7 here]

[Insert Table 8 here]

#### **4.4 Manufacturing vs wholesalers**

Small manufacturing firms can choose to export through exporters in manufacturing or exporting wholesalers. Therefore, the propagation effects may vary by such kind of export mode. Here, we focus on two popular and representative cases: (1) a manufacturing firm's upstream supplier and downstream customer are manufacturers and (2) a manufacturing firm's upstream supplier and downstream customer are wholesalers. Table 9 presents the results. Columns 1-2 report the results for case (1) and columns 3-4 report the results for case (2), respectively. The results show that manufacturing firms respond significantly to both upstream and downstream exchange rate exposure when both their suppliers and customers are manufacturers. When Yen depreciates, the import cost of their suppliers *increase* and the export price of their customers *decrease*, the net effect turns to be positive ( $0.107 = 0.181 - 0.074$ ). Surprisingly, for case (2), the responses of sales and profitability are not quite significant to exchange rate exposure when their suppliers and customers are wholesalers. It suggests that compared with exporters/importers in manufacturing industry, wholesalers play a quite different role in international trade in terms of intermediary, trade credit, logistics and other functions. These important functions of wholesalers may buffer the exchange rate shocks and mitigate the propagation effects on indirect importers/exporters.

[Insert Table 9 here]

#### 4.5 Second degree propagation effects

Recalling the example mentioned in the Introduction about Toyota and its major supplier of Denso, which has more than 1500 small sub-suppliers, it is interesting to examine the second degree propagation effects of exchange rate shocks on firm performance. Now we have six types of exchange rate exposure for a firm: (1) its supplier's supplier's exposure (2<sup>nd</sup> degree upstream), (2) its supplier's exposure (1<sup>st</sup> degree upstream), (3) its direct exposure if it imports directly, (4) its direct exposure if it exports directly, (5) its customer's exposure (1<sup>st</sup> degree downstream), and (6) its customer's customer's exposure (2<sup>nd</sup> degree downstream). Table 10 presents the results. Columns 1-2 use full sample without missing growth rate and columns 3-4 focus on manufacturing firms (direct, upstream and downstream), respectively. From columns 1 to 4, we can confirm both the first and second degree of upstream propagation effects with statistical

significance from the downstream export side. If we compare the coefficients of them, we can see that the magnitude of 1<sup>st</sup> degree effect is larger than the 2<sup>nd</sup> degree effect in all columns. It suggests that the upstream propagation effects decays gradually as it transmit through production chains. On the other hand, the downstream propagation effect from upstream import side is not very clear. Though we can observe the 1<sup>st</sup> degree effect, the 2<sup>nd</sup> degree effect is not statistically significant. This pattern holds when we use the sample of manufacturer-manufacturer pairs only.

[Insert Table 10 here]

## 5 Conclusion

In this paper, we utilize a very rich buyer-supplier data combined with international trade data to analyze how exporters (importers) and their suppliers (buyers). i.e., indirect exporters (importers) respond to exchange rate shocks. Constructing firm specific exchange rate exposure of own firm, upstream and downstream firms and controlling for firm and year fixed effects, we show that beyond direct exchange rate exposure, the propagation effect of exchange rate shocks do affect firm performance through buyer-supplier linkage. A real depreciation of Yen not only significantly increase the sales and profitability of Japanese firms, but also increase the sales and profitability of indirect exporters. On the other hand, the responses to upstream exchange rate shocks and exposures are weak. To our knowledge, this paper is the first to document these new facts. In particular, we find indirect exporters are likely to increase their sales and profitability in response to exchange rate depreciations in downstream industries and firms (upstream propagation effect). This pattern is especially significant and strong for small- and medium-sized enterprises. Our results suggest that the stabilization of exchange rate is crucial to firm performance, especially to the small and medium enterprises engaging in indirect exporting, from the perspective of supply chains. Understanding this phenomenon is very important to both economists and policymakers since large exchange rate shocks are likely to transmit from the exporters to the indirect exporters, propagate to the whole economy and cause macroeconomic fluctuations.

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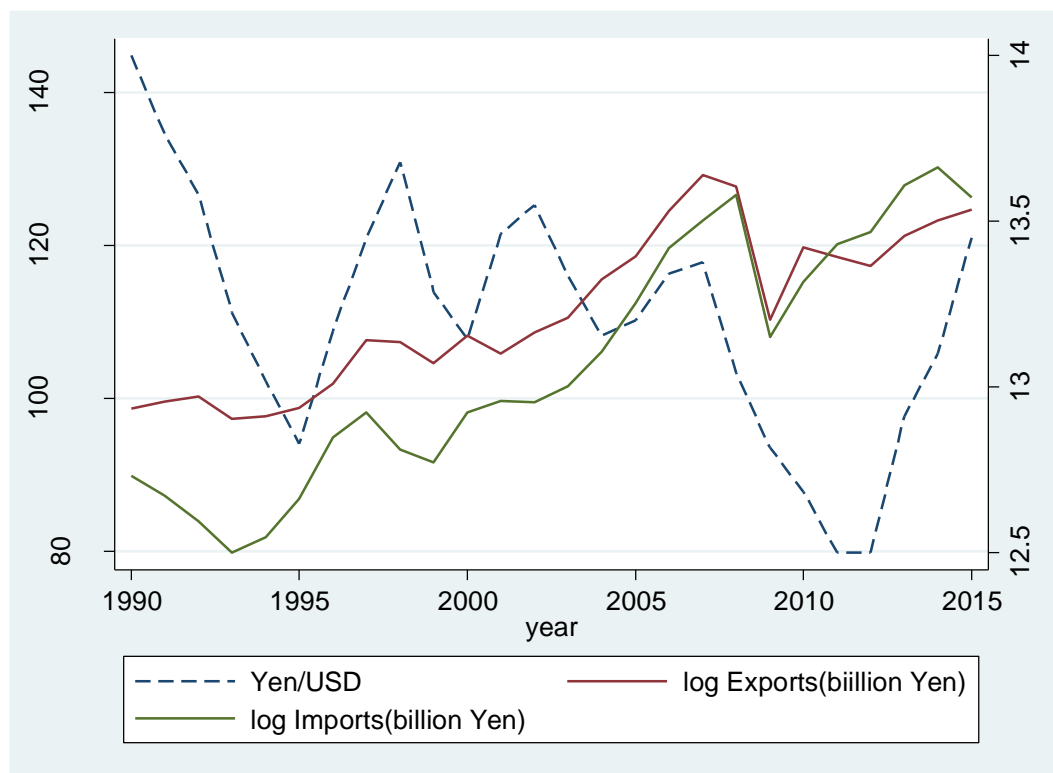
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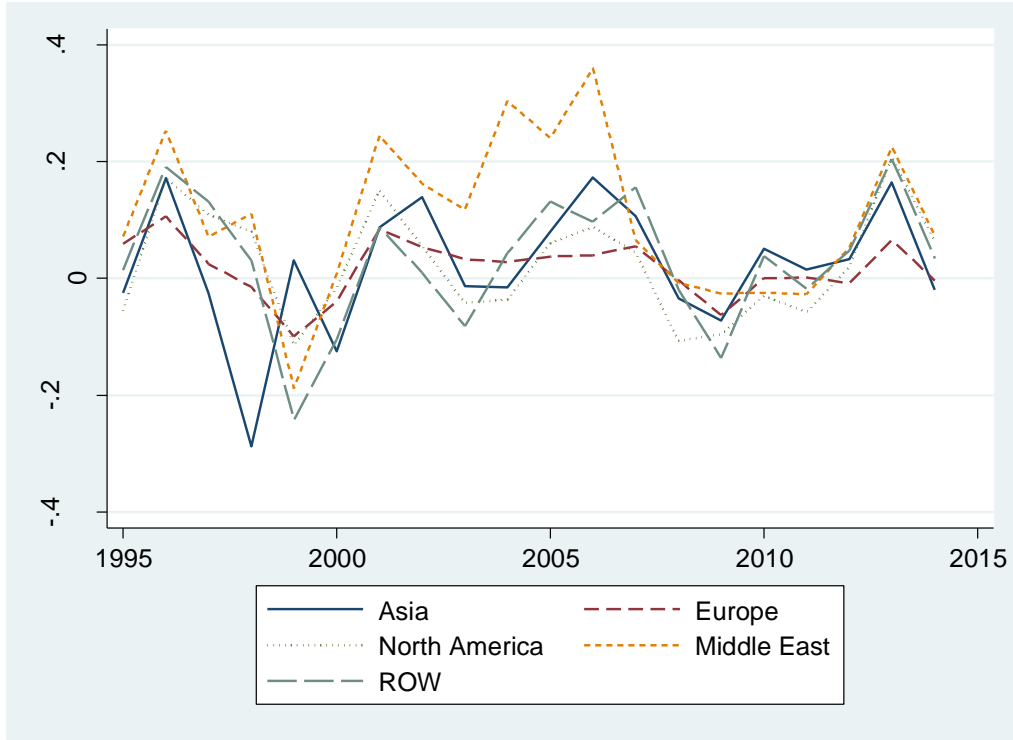
## Figures and Tables

**Figure 1. Japan's exchange rate and trade**



Note: Yen/USD spot rate at 17:00 in JST, average in the month, Tokyo market. An increase in Yen/USD exchange rate implies a depreciation of Yen. Export and import values are in billion Yen. Source: BOJ Time-Series Data Search, Bank of Japan. Trade Statistics of Japan, Ministry of Finance.

**Figure 2. Fluctuations of Japan's exchange rates against trading regions**

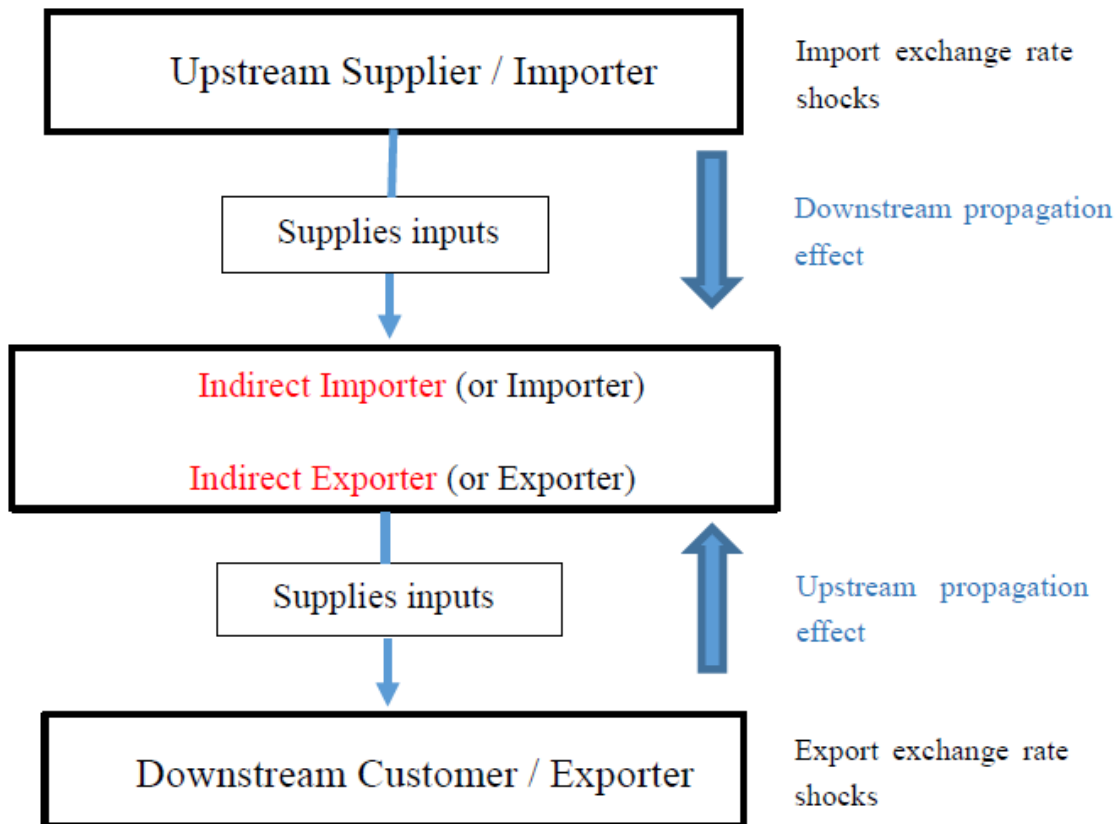


Note: The changes of regional real exchange rates are calculated as follows:

$$\Delta RER_{rt} = \sum_r \frac{GDP_{ct}}{GDP_{rt}} \times \Delta \ln RER_{J/c,t}; \quad RER_{J/c,t} = \frac{NER_{J/US,t}}{NER_{c/US,t}} \times \frac{CPI_{ct}}{CPI_{Jt}}, \text{ where } t \text{ is year and } c$$

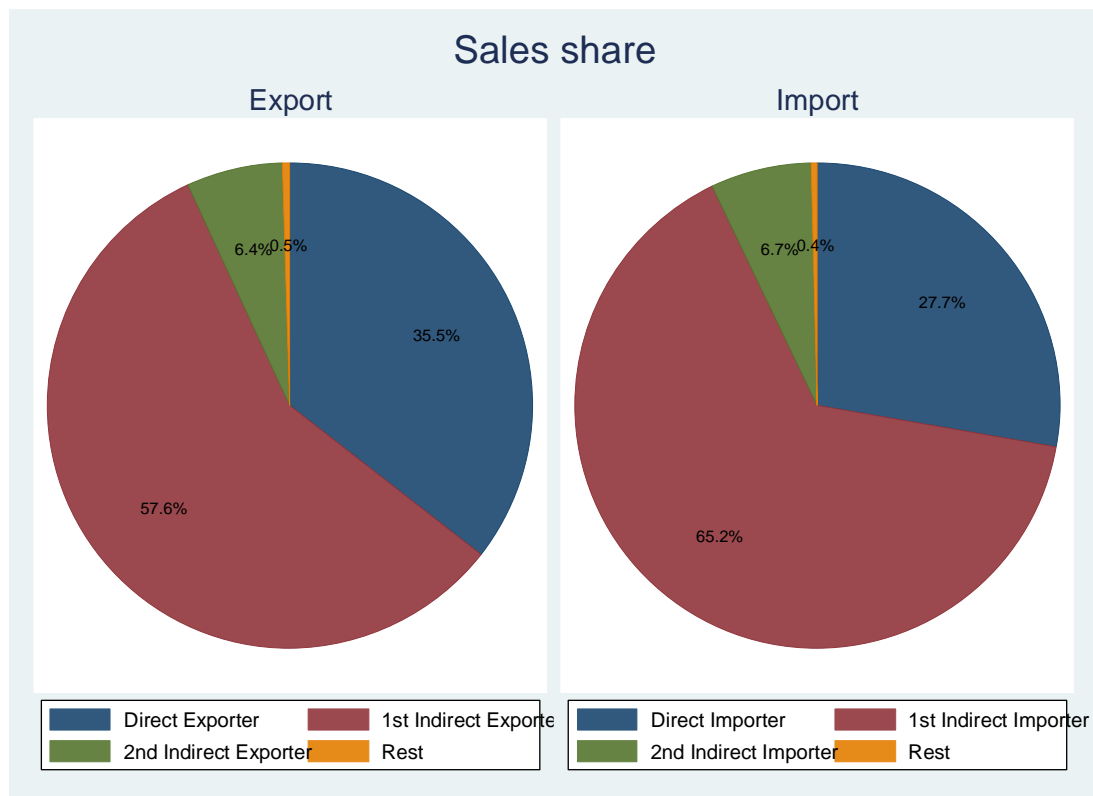
is country respectively.  $r$  denotes Asia, Middle East, Europe, Northern America, or rest of the world (ROW). Bilateral exchange rate (local currency/US Dollar), GDP measured at constant price and consumer price indices (CPIs) are obtained from PWT9 database.

Figure 3. Definition of upstream/downstream propagation effect



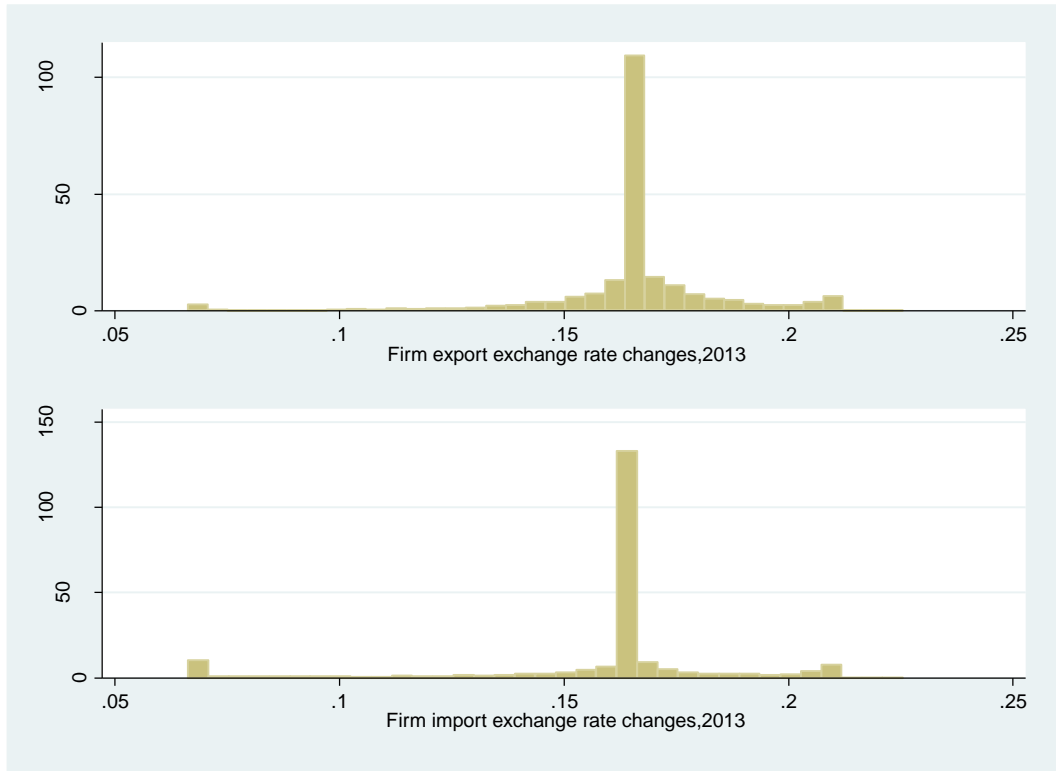
Note: Direction of upstream/downstream propagation effect is defined from the perspective of supply chains.

**Figure 4. Sales share of indirect exporters/importers (2013)**



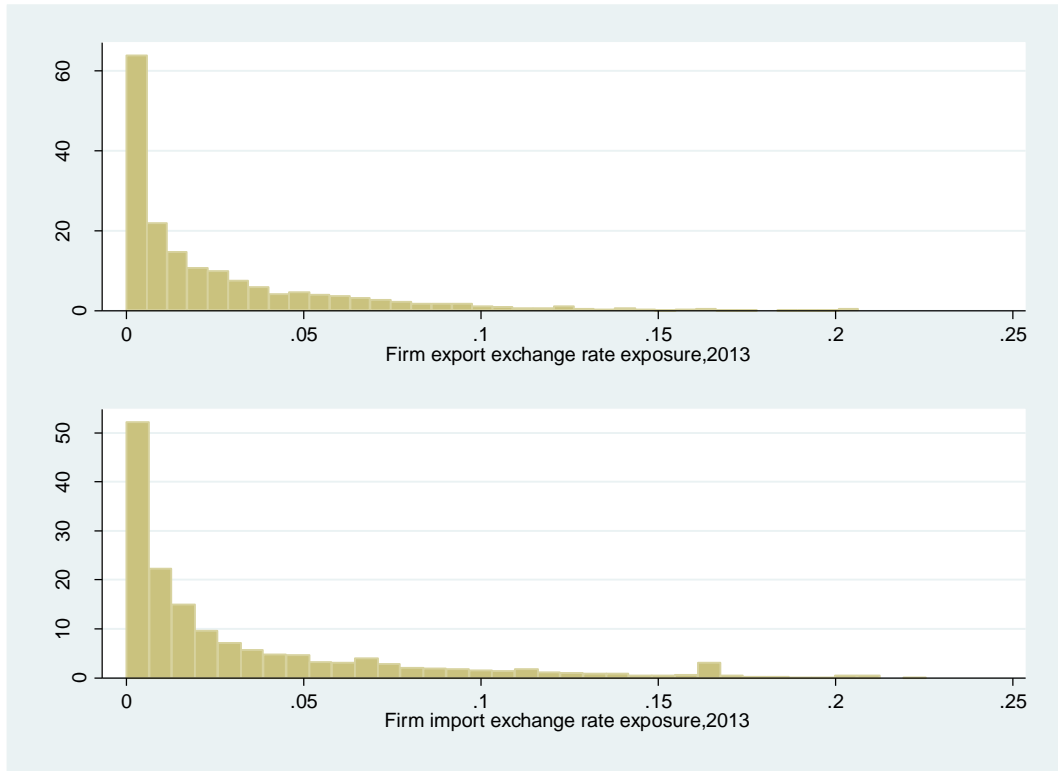
Note: TSR-Kikatsu data 1 contains exporters/importers (defined by exports/imports information in Kikatsu data) and their suppliers/buyers in manufacturing and wholesaling sectors in TSR data.

**Figure 5A. Distribution of export/import exchange rate changes (2013)**



Note: Firm-level export real exchange rate changes  $EXEER_{ft}$  is regional exports and GDP weighted. Firm-level import real exchange rate changes  $IMEER_{ft}$  is regional imports and GDP weighted. The correlation between  $EXEER_{ft}$  and  $IMEER_{ft}$  is 0.32.

**Figure 4B. Distribution of export/import exchange rate exposure (2013)**



Note: Firm-level export exchange rate exposure  $EXEER_{ft} \times exshare_{ft-1}$  equals to the change of export real exchange rate and firm's export share (exports/sales). Firm-level import exchange rate exposure  $IMEER_{ft} \times imshare_{ft-1}$  equals to the change of import real exchange rate and firm's import share (imports/total sourcing). The correlation between  $EXEER_{ft} \times exshare_{ft-1}$  and  $IMEER_{ft} \times imshare_{ft-1}$  is 0.14.

**Table 1. Direct and indirect exporters/importers (2013)**

Panel A: Export		Direct	Indirect 1	Indirect 2	Rest	Total
TSR data	# of firms	13,174	132,689	81,387	9,549	236,799
	Share	6%	56%	34%	4%	100%
TSR-Kikatsu 1	# of firms	3,762	125,732	52,426	4,451	186,371
	Share	2%	68%	28%	2%	100%
TSR-Kikatsu 2	# of firms	3,851	5,941		732	10,524
	Share	37%	57%		7%	100%
Panel B: Import		Direct	Indirect 1	Indirect 2	Rest	Total
TSR data	# of firms	20,427	132,011	77,547	6,814	236,799
	Share	9%	56%	33%	3%	100%
TSR-Kikatsu 1	# of firms	3,548	122,997	56,153	3,673	186,371
	Share	2%	66%	30%	2%	100%
TSR-Kikatsu 2	# of firms	3,614	6,115		795	10,524
	Share	34%	58%		8%	100%

Note: TSR data refers to original TSR data in 2013 that contains firms' trade status which is categorized to exporting, importing, both exporting and importing, and domestic (non-exporting and non-importing) firms. This trade status variable is only available in 2013. The matched TSR-Kikatsu 1 contains exporters/importers (defined by exports/imports information in Kikatsu data) and their suppliers/buyers in manufacturing and wholesaling sectors in TSR data. The matched TSR-Kikatsu 2 are restricted to firms that have both buyer-supplier linkage information in TSR data and firm-level variables (including exports/imports information) reported in Kikatsu data.

**Table 2. Direct effects of exchange rates shocks**

	(1)	(2)	(3)	(4)
Dep. Vars:	$\Delta \ln \text{Sales}$		$\Delta \text{Profitability}$	
$\Delta \text{IMEER} * \text{L.Import share}$	0.06 [0.047]	0.048 [0.048]	-0.076*** [0.020]	-0.067*** [0.016]
$\Delta \text{IMEER} * \text{L.Import share, } t-1$		-0.057 [0.042]		-0.023* [0.014]
$\Delta \text{EXEER} * \text{L.Export share}$	0.291*** [0.075]	0.318*** [0.077]	0.116*** [0.026]	0.121*** [0.026]
$\Delta \text{EXEER} * \text{L.Export share, } t-1$		0.126* [0.072]		-0.013 [0.052]
$\Delta \ln \text{TFP}$	0.228*** [0.007]	0.229*** [0.008]	0.070*** [0.002]	0.071*** [0.002]
$\Delta \ln \text{GDP}$	0.096 [0.068]	0.123* [0.071]	0.055*** [0.020]	0.054** [0.021]
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	88504	79462	88504	79462
R-squared	0.399	0.413	0.29	0.295

Note: The regressions use Kikatsu data for the period 2005 to 2013. All columns include industry-year fixed effects and firm fixed effects. Standard errors clustered at the firm level in parentheses.

\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.



**Table 3. Direct and indirect effects**

Dep. Vars.:	(1)	(2)
	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>		
$\Delta \text{IMEER} * \text{L.Import share}$	0.000 [0.047]	0.061 [0.070]
<b>Direct effect</b>		
$\Delta \text{IMEER} * \text{L.Import share}$	0.099* [0.059]	-0.080 [0.052]
$\Delta \text{EXEER} * \text{L.Export share}$	0.542*** [0.100]	0.390*** [0.129]
<b>Upstream propagation effect</b>		
$\Delta \text{EXEER} * \text{L.Export share}$	0.985*** [0.062]	0.297** [0.129]
Firm controls	Yes	Yes
Firm FE	Yes	Yes
Industry-year FE	Yes	Yes
Observations	100928	100928
R-squared	0.198	0.015

Note: The regressions use the matched data TSR-Kikatsu 2 for the period 2005 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm TFP growth and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 4. Pure indirect exporters/importers**

	(1)	(2)	(3)	(4)
	<b>Direct export/import</b>		<b>Indirect export/import</b>	
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	-0.027 [0.075]	-0.019 [0.032]	0.034 [0.064]	0.143 [0.141]
<b>Direct effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.074 [0.069]	-0.101*** [0.038]	0 [.]	0 [.]
$\Delta \text{EXEER} * \text{L.Export share}$	0.298*** [0.101]	0.195** [0.091]	0 [.]	0 [.]
<b>Upstream propagation effect</b>				
$\Delta \text{EXEER} * \text{L.Export share}$	0.546*** [0.091]	0.049 [0.045]	0.933*** [0.087]	0.399* [0.241]
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	34501	34501	47603	47603
R-squared	0.367	0.195	0.325	0.014

Note: The regressions use the matched data TSR-Kikatsu 2 for the period 2005 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm TFP growth and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 5. Firm size: Large firms vs SMEs**

	(1)	(2)	(3)	(4)
	<b>Large firms</b>		<b>SMEs</b>	
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.144 [0.113]	0.019 [0.029]	-0.008 [0.052]	0.066 [0.077]
<b>Direct effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	-0.061 [0.088]	0.000 [0.035]	0.118* [0.071]	-0.099 [0.062]
$\Delta \text{EXEER} * \text{L.Export share}$	0.965*** [0.133]	0.340*** [0.051]	0.373*** [0.143]	0.401** [0.184]
<b>Upstream propagation effect</b>				
$\Delta \text{EXEER} * \text{L.Export share}$	0.808*** [0.142]	0.063 [0.043]	0.991*** [0.068]	0.334** [0.150]
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	16238	16238	84690	84690
R-squared	0.25	0.125	0.213	0.015

Note: The regressions use the matched data TSR-Kikatsu 2 for the period 2005 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm TFP growth and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 6. Direct and indirect effects: Including small firms (<50 employees)**

	(1)	(2)	(3)
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>			
$\Delta \text{IMEER} * \text{L.Import share}$	-0.027 [0.018]	-0.031 [0.025]	-0.024*** [0.007]
<b>Direct effect</b>			
$\Delta \text{IMEER} * \text{L.Import share}$	0.205** [0.088]	0.189** [0.090]	-0.117* [0.063]
$\Delta \text{EXEER} * \text{L.Export share}$	0.561*** [0.189]	0.553*** [0.192]	0.513** [0.229]
<b>Upstream propagation effect</b>			
$\Delta \text{EXEER} * \text{L.Export share}$	0.282*** [0.018]	0.338*** [0.024]	0.051*** [0.008]
Firm controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes
Observations	838572	537155	537155
R-squared	0.356	0.373	0.266

Note: The regressions use the matched data TSR-Kikatsu 1 for the period 2009 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm size and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses.

\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 7. Pure indirect exporters/importers: Including small firms (<50 employees)**

	(1)	(2)	(3)	(4)
	<b>Direct export/import</b>		<b>Indirect export/import</b>	
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	-0.097 [0.213]	0.082 [0.090]	-0.030** [0.012]	-0.003 [0.006]
<b>Direct effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.127 [0.095]	-0.119** [0.059]	0 [.]	0 [.]
$\Delta \text{EXEER} * \text{L.Export share}$	0.473** [0.191]	0.325* [0.181]	0 [.]	0 [.]
<b>Upstream propagation effect</b>				
$\Delta \text{EXEER} * \text{L.Export share}$	0.162 [0.155]	0.054 [0.074]	0.285*** [0.019]	0.049*** [0.008]
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	15236	15178	813305	515737
R-squared	0.268	0.072	0.362	0.286

Note: The regressions use the matched data TSR-Kikatsu 1 for the period 2009 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm size and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses.

\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 8. Firm size: Including small firms (<50 employees)**

	(1)	(2)	(3)	(4)
	<b>Large firms</b>		<b>SMEs</b>	
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.551 [0.379]	0.127 [0.107]	-0.029 [0.026]	-0.024*** [0.007]
<b>Direct effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.264* [0.150]	0.042 [0.059]	0.141 [0.102]	-0.154** [0.073]
$\Delta \text{EXEER} * \text{L.Export share}$	0.637*** [0.226]	0.214*** [0.082]	0.757*** [0.292]	0.663** [0.330]
<b>Upstream propagation effect</b>				
$\Delta \text{EXEER} * \text{L.Export share}$	0.136 [0.190]	0.051 [0.065]	0.341*** [0.025]	0.051*** [0.008]
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	13250	13250	523905	523905
R-squared	0.339	0.229	0.375	0.269

Note: The regressions use the matched data TSR-Kikatsu 1 for the period 2009 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm size and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses.

\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 9. Industry: Manufacturing vs wholesaler**

	(1)	(2)	(3)	(4)
Upstream/Downstream:	Manufacturing		Wholesaler	
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	-0.074** [0.033]	-0.02 [0.015]	0.051 [0.038]	-0.018 [0.014]
<b>Direct effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.15 [0.104]	-0.184* [0.096]	0.076 [0.105]	-0.195** [0.096]
$\Delta \text{EXEER} * \text{L.Export share}$	0.573*** [0.197]	0.600** [0.294]	0.674*** [0.221]	0.679** [0.314]
<b>Upstream propagation effect</b>				
$\Delta \text{EXEER} * \text{L.Export share}$	0.181*** [0.030]	0.039*** [0.013]	0.067* [0.037]	0.014 [0.015]
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	222156	164595	175083	132823
R-squared	0.347	0.255	0.361	0.264

Note: The regressions use the matched data TSR-Kikatsu 1 for the period 2009 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm size and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses.

\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.

**Table 10. 2<sup>nd</sup> degree propagation effect**

	(1)	(2)	(3)	(4)
	<b>Full samples</b>		<b>All manufacturing</b>	
Dep. Vars.:	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$	$\Delta \ln \text{Sales}$	$\Delta \text{Profitability}$
<b>Downstream propagation effect</b>				
2nd $\Delta \text{IMEER} * \text{L.Import share}$	-0.052 [0.193]	-0.06 [0.059]	0.222 [0.260]	-0.024 [0.094]
1st $\Delta \text{IMEER} * \text{L.Import share}$	-0.043** [0.018]	-0.002 [0.006]	-0.065*** [0.016]	0.009 [0.006]
<b>Direct effect</b>				
$\Delta \text{IMEER} * \text{L.Import share}$	0.273*** [0.091]	-0.106* [0.064]	0.305*** [0.108]	-0.154* [0.088]
$\Delta \text{EXEER} * \text{L.Export share}$	0.634*** [0.196]	0.518** [0.228]	0.559** [0.221]	0.577** [0.266]
<b>Upstream propagation effect</b>				
1st $\Delta \text{EXEER} * \text{L.Export share}$	0.263*** [0.026]	0.038*** [0.008]	0.184*** [0.030]	0.031*** [0.010]
2nd $\Delta \text{EXEER} * \text{L.Export share}$	0.129*** [0.012]	0.018*** [0.004]	0.155*** [0.017]	0.025*** [0.006]
Firm controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Industry-year FE	Yes	Yes	Yes	Yes
Observations	537155	537155	287193	287193
R-squared	0.374	0.266	0.364	0.261

Note: The regressions use the matched data TSR-Kikatsu 1 for the period 2009 to 2013. Upstream and downstream exchange rates exposure are simple average. Own firm controls include firm size and trade weighted GDP growth rate. Standard errors are clustered at the firm level in parentheses.

\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level, respectively.